

Imaging Workshop White Paper

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It has become increasingly clear that our local region in the universe we call the Solar System, is comprised of a collection of coupled systems. In fact it is one large system-of-systems with our star, the Sun, as the primary source of energy and center of organization. Earth, as our home, is the planet we know most about. We have ventured quite successfully into Earth's immediate surrounding, called Geospace. We have learned some things about how Geospace is intrinsically connected over diverse scales of space and time to the dynamic plasma and energy emanating from the Sun. Over time a sizeable armada of spacecraft probing various regions and aspects of the Earth-Solar System has been assembled. Their collective observations have given us a glimpse into the extent of the coupled nature of the Solar System.

We are now poised to venture beyond our immediate surrounding, driven by the vision to extend and find life beyond Earth as we explore the Solar System and the universe beyond, while improving, understanding and protecting life here. In our quest to explore the Solar System, tools must be available and a level of understanding must be achieved that allow wise decisions to be made throughout this epoch of exploration. The investment of national resources and public expectations for future generations demands this. Considering the complexity and coupled nature of the Sun-Earth-Solar System, a well fashioned strategy is required. By the very nature of coupled systems, observation of system components and their relationships is critical to effectively understand and characterize the collective behavior. Imaging is the tool that most effectively meets this need. Understanding of the complex interrelationships is impossible without global imaging of Geospace and the Sun-Heliospheric system. Imaging provides more information than any practical number of distributed single-point measurements and therefore is indispensable for system level exploration.

An effective strategy to explore the Solar System will be based on the recognition that probing all regions of space is not possible and that understanding of the environment that is encountered during exploration is vital to the safety of our explorers and technological assets. Therefore reliance on models that predict environments and explain observations is required for exploration. The development of these models necessarily depends on understanding the mechanisms and coupling processes that are at work in the regions being explored. The knowledge required for this understanding is often most effectively gained by exploring analogous systems that are more easily accessible, such as in Geospace, or readily observable, such as at the Sun. Imaging plays a unique and necessary role in providing observations of system level interactions and processes that are not possible otherwise. Imaging constrains theories and models used to describe mechanisms operating throughout the Solar System.

The following input is provided to the Sun-Solar System Connections Roadmap. It emphasizes the required role that imaging plays in understanding, characterizing and exploring the connected Sun-Solar System and the Universe beyond. The power of imaging is understood, by analogy, in the comprehension that is realized when looking at picture of a complex machine or system. Insights and understanding of complex systems are very effectively gained with our vision when compared to other methods of communication such as words or graphs of numeric quantities. Examples of imaging techniques, the processes addressed by imaging, and technologies required to advance are provided in the Solar-Helio and Geospace white papers.